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Charcoal analysis of a Late Iron Age ironworking site at Ronse Pont West (prov. East Flanders, Belgium)

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1. Introduction

Rescue excavations carried out between 2011 and 2014 by the intermunicipal utility company SOLVA provided indications for long-term human activities at the site of Ronse Pont West (fig. 1). The oldest finds date from the upper Paleolithic (Vandendriessche *et al*. 2016), the earliest building remains date from the middle Bronze Age A (De Graeve *et al.* 2014; De Graeve *et al*. 2018). For the Late Iron Age/Early Roman period, human occupation on the site is attested by many pits, ditches and graves (De Graeve 2018). There is a gap in the occupation of the site between the 2th century BC and the 9th century AD. From the High Middle Ages onwards, the site was uninterruptedly inhabited until the present day.

The excavated Iron Ages features at the site of Ronse Pont West include six pits containing iron working debris (slags, hammerscale, etc.). These pits do not show traces of *in situ* burning of the soil, but the presence of hammerscale and furnace lining indicate that the blacksmith's activities were carried out in the immediate proximity of the pits. Probably, the forge in which the blacksmith's working area was, was dug into the ground while the actual hearth was on walking level, as is known from a contemporary smithing site in Switzerland (De Graeve & Windey 2018). The detailed analysis of the iron working debris (slags, hammerscale, …) showed that the fill of these pits represents the remains of secondary smithing activities on the level of the household (De Graeve & Windey 2018). As there is no evidence for on-site bloomery, primary iron production was probably done elsewhere and the blacksmith working in Ronse Pont West must have worked with iron imported as ingots, bars or billets, or with recycled iron objects.

This publication now presents the results of the analysis of the charcoal that was recovered from one of these pits[3] (pit I-A-41) which was associated with the metal working debris. In addition, also the charcoal from a charcoal production kiln, that was excavated at the same site, has been studied, to verify whether the charcoal produced in the kiln might have been used for the metal working. This feature, I-A-97, was a shallow pit with an irregular outline with rounded corners and a flat bottom. At the bottom of the pit, there was a layer of charcoal and fragments of burnt loam. Also the sides of the pit locally showed traces of in situ burning. All these characteristics are typical elements of charcoal pit-kilns (e.g. Deforce *et al*. in press).

2. Material and methods

Bulk samples taken from the fill of pit I-A-41 and from charcoal pit-kiln I-A-97 were wet-sieved (mesh size 0.5 mm) with tap water and the residues were air-dried for one week. From pit I-A-41, a minimum of 100 charcoal fragments were randomly selected, independent of their size. From I-A-97, only a small sample was available for analysis and all charcoal fragments present in the residue have been studied. The charcoal fragments were identified using a microscope with incident dark field illumination and following standardised procedures (Gale & Cutler 2000). Identifications are based on wood anatomy identification literature (Schweingruber 1990; Schoch *et al*. 2004) and the anthracological reference collection of the Royal Belgian Institute of Natural Sciences. The nomenclature of the identified wood types follows Schweingruber (1990).

3. Results and interpretation

Four samples, all unidentified charcoal fragments, from two of the pits with smithing debris have been dated in a previous study (De Graeve & Windey 2018; table 1; fig. 2). One of these samples produced a much older result compared to the other 3 samples, and is considered as an outlier, probably as a result on an old wood effect. The other results date the smithing activities between ca. 365 cal BC and 104 cal BC (table 1; fig. 2). Assuming that both pits are more or less contemporaneous, and combined with the results of the pottery analysis, the smithing activities at Ronse Pont West can most likely be dated between 235 cal BC and 173 cal BC (De Graeve & Windey 2018).

The charcoal kiln however dates between 554 cal AD and 644 cal AD, which indicates that there is no relation between the charcoal kiln and the smithing activities (table 1; fig. 1).

A total of 151 charcoal fragments have been studied from I-A-41, resulting in a minimum of six different identified taxa (table 2). Oak (*Quercus* sp.) is the dominant taxon with 75.2 %, and also the apple subfamily (Maloideae)[4] (12.4 %)

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[3] Unfortunately, no samples from the other pits with metal working debris were available for analysis.

[4] This is a group of taxa within the Rosaceae family and includes apple (*Malus* sp.), pear (*Pyrus* sp.) and hawthorn (*Crataegus* sp.).

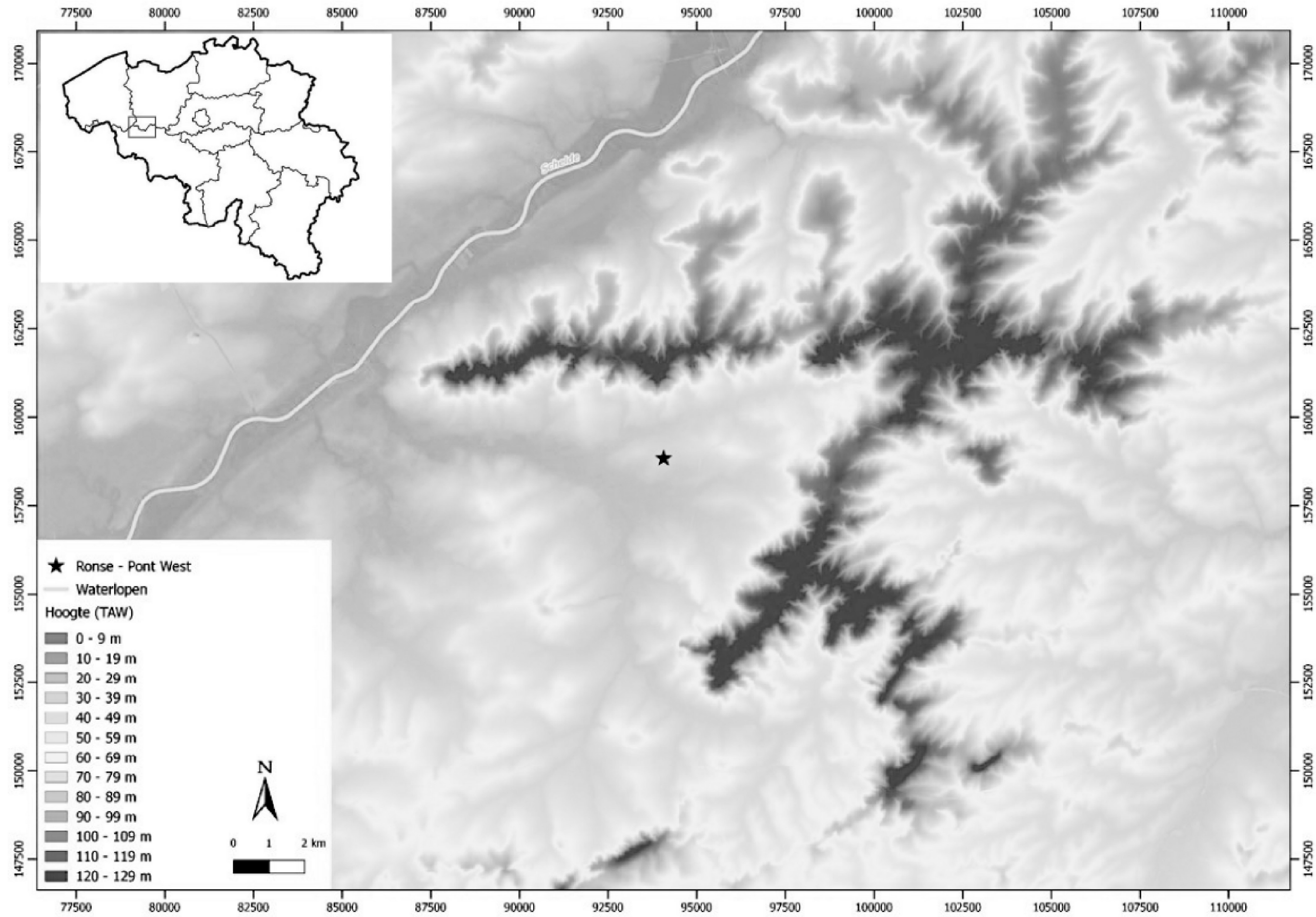

Fig. 1. Location of the site on the digital elevation model

Feature	Sample	Lab-code	Age (uncal BP)	Age (cal BC/AD, 2σ range)
I-A-8	charcoal indet.	RICH-22967	2367 ± 29	536 (95.4%) 387 cal BC
I-A-8	charcoal indet.	RICH-22957	2157 ± 28	357 (37.9%) 282 cal BC 257 (1.1%) 246 cal BC 236 (56.4%) 104 cal BC
I-A-41	charcoal indet.	RICH-22254	2197 ± 30	365 (95.4) 184 cal BC
I-A-41	charcoal indet.	RICH-22258	2179 ± 30	362 (95.4%) 167 cal BC
I-A-97	charcoal (*Quercus* sp.) cf. sapwood	RICH-26513	1466 ± 25	554 (95.4%) 644 cal AD

Table 1. Results of the radiocarbon analysis. Calibrations were done with OxCal v4.3.2 (Bronk Ramsey 2009) using the IntCal13 atmospheric curve (Reimer et al. *2013). I-A-8 and I-A-41 are pits with smithing debris, I-A-97 is a charcoal kiln.*

is important in the charcoal assemblage. Other taxa that have been identified are birch (*Betula* sp.), hazel (*Corylus avellana*), dogwood (*Cornus* sp.) and willow (*Salix* sp.), but all with low percentages.

All these taxa are native to the region and can have occurred in the vicinity of the site (Maes *et al*. 2006). As pit I-A-41 contains a lot of metal working debris, it is estimated that the majority of the charcoal fragments in the pit also represents waste from metal working activities. Except for willow, which occurs only in small percentages in the charcoal assemblage of the pit, all identified taxa produce wood with a high density and thus excellent fuelwood which might have been selected deliberately as metalworking requires high temperatures (Gale 2003; Deforce 2017). Especially oak and the apple subfamily have high densities of 710 and 700 kg/m^3 respectively (EN 350-2 1994; FEM 2009). Whether the wood used as fuel for the iron working activities was converted to charcoal prior to use is not clear however. Charcoal produces higher temperatures compared to wood and it is assumed that for iron melting in a bloomery furnace, charcoal was an indispensable fuel, as the required temperatures for iron smelting

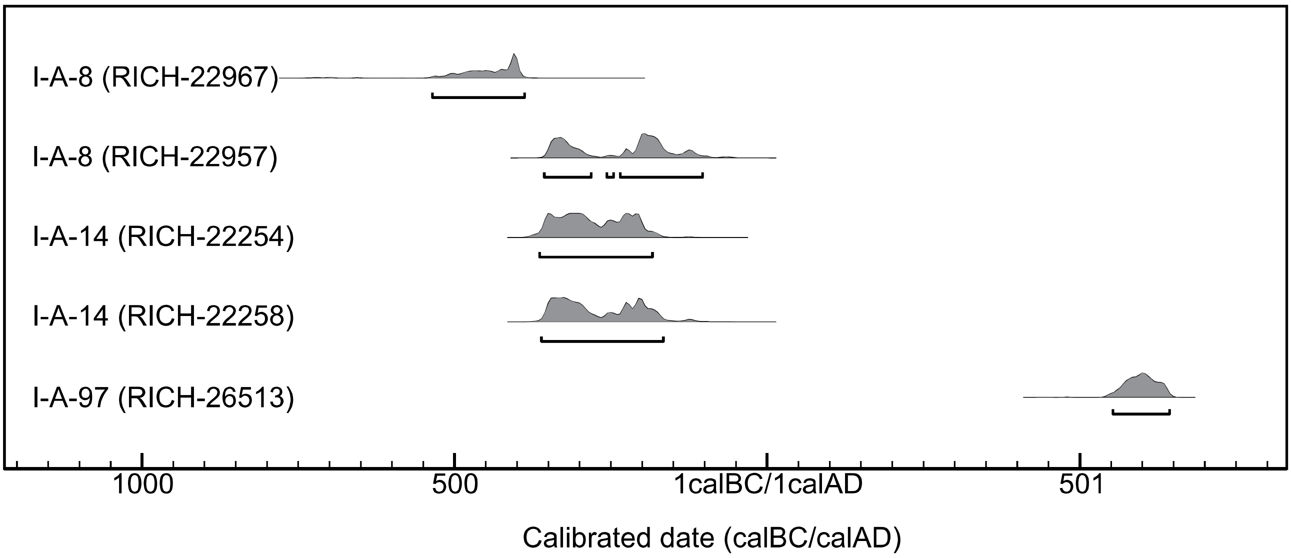

Fig. 2. Multiplot with calibrated age distributions (95.4% probability range) of pit I-A-8, I-A-41 and I-A-97 (OxCal v4.3 Bronk Ramsey 2009); IntCal13 atmospheric curve (Reimer et al. *2013).*

feature	**I-A-41 smithing debris**		**I-A-97 charcoal kiln**		
age	365 – 167 **cal BC**		**554 – 644 cal AD**		
	N	**%**	**N**	**%**	
Betula sp.	3	2.1	-	-	birch
Corylus avellana	8	5.5	-	-	hazel
Cornus sp.	1	0.7	-	-	dogwood
Maloideae	18	12.4	-	-	apple subfamily
Quercus sp.	109	75.2	57	100.0	oak
Salix sp.	6	4.1	-	-	willow
total identified	145	100	57	100	total identified
bark indet.	1	-	-	-	bark indet.
indet	5	-	-	-	indet
total det. + indet.	151	-	57	-	total det. + indet.

Tabel 2. Results of the charcoal identifications.

cannot be reached using wood fuel. For Iron Age smithing activities however, it is not known whether wood was converted to charcoal prior to its use as fuel. No Iron Age charcoal production kilns have been found at the site or in the wider region. The only charcoal kiln excavated at the site (I-A-97) dates to the Early Medieval period. In Belgium, the only Iron Age charcoal kilns known up to now have been found in Roeselare, Staden and Arlon (Beke *et al.* 2017; Vanhoutte 2018; Drailly & Deforce 2019). In the Netherlands, Iron Age pit kilns are known from Anloo and Heeten (Groenewoudt 2005; Van der Velde 2007) and in France, Iron Age pit kilns have been excavated in Saint-Martin-d'Ary (Charante-Maritime), Enversin (Rhône) and Ille-et-Villaine (Mans) (Gasc *et al.* 2018; Lurol & Cabanis 2012; Vivet 2007). These charcoal kilns, and also charcoal kilns dating to the Roman Age and medieval period, generally have a monospecific charcoal assemblage with mostly oak (*Quercus* sp.) or sometimes beech (*Fagus sylvatica*) or alder (*Alnus* sp.) being the single or very dominant wood taxon (Drailly & Deforce 2019; Marinova & Deforce 2014; Deforce *et al*. 2013; 2015, 2017; in press, Gasc *et al*. 2018). The much larger number of taxa present in the charcoal assemblage of pit I-A-41 might be an indication that charcoal was not (exclusively) used as fuel for the smithing activities. It cannot be excluded however that part of the charcoal in this pit originates from domestic fuel use as the presence of pottery fragments and burned bone indicates that also domestic refuse has been dumped in the pit. Another possibility is that residual charcoal from domestic hearths was collected for re-use as fuel for smithing activities. Also the presence of fragments of burnt animal bone in the pit could be an indication for the use of charcoal recovered from domestic fireplaces, rather than the use of intentionally produced charcoal in charcoal kilns (e. g. Baeten *et al*. 2014).

4. Conclusions

Charcoal from an Iron Age pit with smithing debris and from a nearby excavated charcoal kiln has been studied. Radiocarbon analyses showed that both features are not contemporary however, with the charcoal kiln dating to the Early Medieval period. Moreover, the charcoal assemblage from the pit with smithing debris shows a much higher taxonomic diversity than the assemblages of charcoal kilns, both Iron Age and younger kilns. The results indicate that is possible that the fuel used for small scale smithing activities during the Iron Ages was not charcoal produced in charcoal kilns but more likely residues recovered from domestic fires.

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